Space Weather Technical Forecast

Issued on Friday, 31 May 2024 at 00:29 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of isolated X-class flares on all days. Chance of G1-G2/Minor to Moderate geomagnetic storm activity, mainly day 2 (01 June).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was at Moderate levels, with a peak M1.0 flare at 30/0713 UTC from AR3691 (Dkc/Beta-Gamma-Delta) in the north-centre disc. This region, as well as AR3697 (Eki/Beta-Gamma-Delta) in the southeast produced numerous low-level C-class flares during the period.

There are currently six numbered and one un-numbered regions on the visible disc. AR3697 (ex-AR3664), the largest region on the disc rotated into clearer view with of one or more delta spots persisting within the interior of the group. Overall it evolved slowly though with little change in overall size and appearance. AR3691 (Ex-AR3663), also a moderately large region, supported a single delta spot in the intermediate portion of the group, however, there were signs of some separation in the penumbra between the spots of opposing polarity and reduction in overall penumbral extent of the region. The other sunspot groups on the disc are small, simple and appear stable at this time. AR3696 in the northeast disc decayed during the period.

No new Earth-directed CMEs were observed in available imagery.

Solar Wind / Geomagnetic Activity: Solar winds were indicative of slow-ambient wind conditions, with background speeds observed by ACE at L1, between 320-380km/s. The Interplanetary Magnetic Field (IMF), Bt, varied between weak and moderate levels, with a peak of 9nT at 30/1424 UTC. The north-south component, Bz, was predominately positive (northward) until around 30/1045 UTC, after which largely negative (southward) values were observed. Bz ranged between +6/-9nT. Phi angle was mostly positive (away from the Sun) but became largely negative (towards the Sun) late in the UTC day on 30 May. Geomagnetic activity was Quiet to Unsettled (Kp 1-3).

Energetic Particles / Solar Radiation: High energy proton flux at GOES18 (greater than 10 MeV) remained at background with no solar radiation storms occurring. High energy electron flux (greater than 2MeV) at GOES16 varied between background and moderate. Associated 24-hour fluence remained below the Active threshold. Observed fluence at 31/0000 UTC was 6.61e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity is expected, with a chance of isolated X-class flares throughout the period. AR3697 in the southeast and AR3691 in the north-centre disc provide the bulk of the current significant flare risk.

Solar Wind / Geomagnetic Activity: A CME that left the Sun on 29 May from the X1.4 flare of AR3697 has been modelled as a potential glancing blow at Earth on day 2 (01 June), with a chance for an earlier arrival time very late on day 1 (31 May). No other Earth-directed CMEs currently feature in the forecast.

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Solar winds are likely to persist at background through day 1 (31 May) and day 2 (01 June) in the absence of any potential CME arrival. A small positive coronal hole in the northwest disc could give a modest enhancement from late day 2 (01 June) or day 3 (02 June). Any connection to this feature should see speeds peak at slightly elevated levels on day 3 or 4 (02 or 03 June).

Geomagnetic activity is expected to be mainly Quiet on day 1 (31 May) with a chance of isolated Unsettled intervals. Any early arrival of the 29 May CME, could see activity increase to G1-G2/Minor-Moderate Storm levels late on day 1 (31 May), though this is considered more likely on day 2 (01 June). On day 3 (02 June), there is a slight chance of peak G1/Minor Storm conditions resulting from minor coronal hole and possible residual CME influence, otherwise activity should be at Quiet to Unsettled levels, easing to become Quiet by day 4 (03 June).

Energetic Particles / Solar Radiation: High energy proton flux is expected to persist at background levels, with a slight chance of rising above the S1/Minor Storm threshold given any further notable flares. High energy electron flux (>2MeV) is forecast to remain at background to moderate levels on all days, with the associated 24 hour fluence forecast to remain below the Active threshold.

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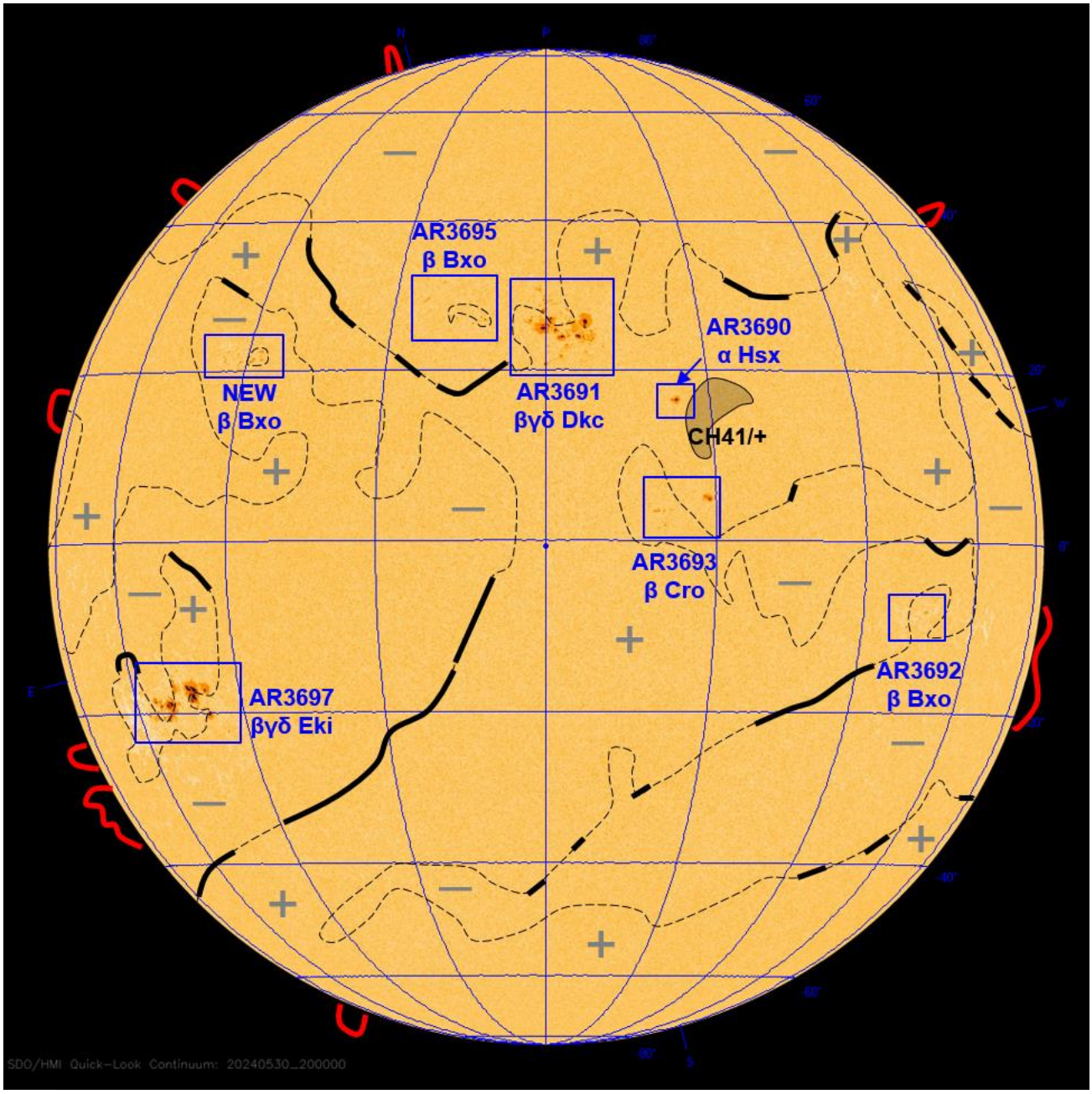
Figure 1. Solar Analysis Valid 30/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A CME that resulted from the X1.4 flare of AR3697 on 29 May has been modelled as a potential glancing blow at Earth on day 2 (01 June), although the bulk of the ejecta is expected to pass behind Earth orbit. Confidence in the fit of this feature to coronagraph imagery is moderate given a partial data gap in the hours immediately following the eruption, therefore there is considered to be a chance of an earlier arrival very late on day 1 (31 May). No other Earth-directed CMEs currently feature in the forecast.

A number of large filaments currently occupy the near centre-disc region of the Sun. Should any of these erupt in the coming days there is a likelihood for ejecta to be Earth-directed, so these regions will be closely monitored for any developments.

Solar winds are likely to persist at background through day 1 (31 May) and day 2 (01 June) in the absence of any potential CME arrival. Small coronal hole CH41/+, in the northwest disc could give a modest enhancement from late day 2 (01 June) or day 3 (02 June). This is a recurrent feature from the last rotation, but much changed, appearing significantly smaller and therefore likely to be less strong than the maximum (550km/s) speeds observed in early May. Any connection to this feature should see speeds peak at slightly elevated levels on day 3 or 4 (02 or 03 June).

Geomagnetic activity is expected to be mainly Quiet on day 1 (31 May) with a chance of isolated Unsettled intervals. Any early arrival of the 29 May CME, could see activity increase to G1-G2/Minor-Moderate Storm levels late on day 1 (31 May), though this is considered more likely on day 2 (01 June). On day 3 (02 June), there is a slight chance of peak G1/Minor Storm conditions resulting from minor coronal hole and possible residual CME influence, otherwise activity should be at Quiet to Unsettled levels, easing to become Quiet by day 4 (03 June).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	40	10	1
Strong	G3	No	5	10	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
29/2008	Partial Halo	X1.4 flare	AR3697	647 km/s	01/0700 UTC	Moderate confidence in timing and impacts. Most likely a glancing blow.

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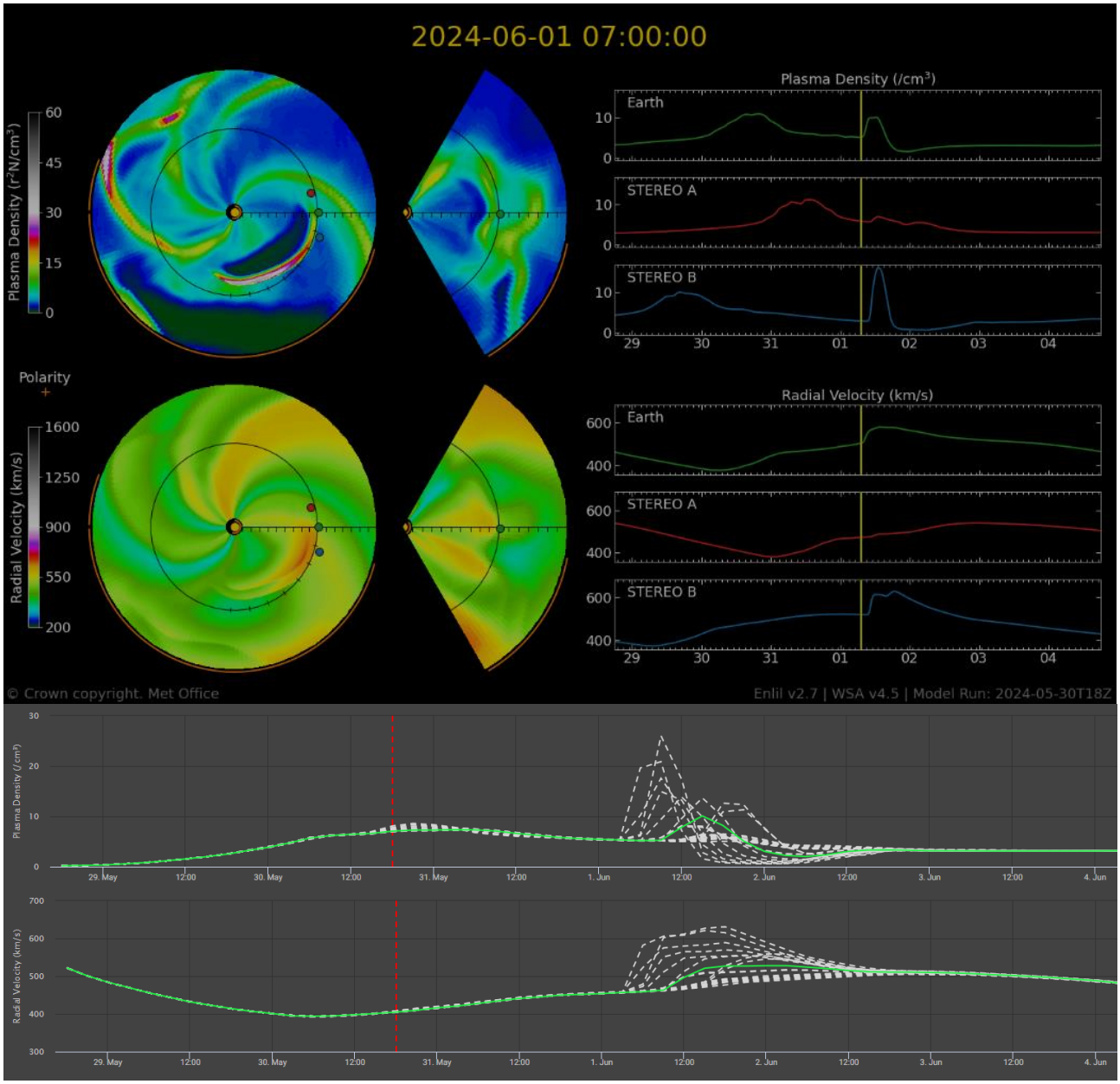
Figure 2: MOSWOC Enlil and Ensemble forecast showing potential glancing CME arrival on 01 June. Note Enlil likely too strong with coronal hole fast winds from 31 May onwards.



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Radio Blackouts - X-Ray Flares:

There are currently six numbered and one un-numbered regions on the visible disc. The largest region on the disc remains AR3697 (Eki/Beta-Gamma-Delta) in the southeast. Now rotated into a less oblique viewing angle, it clearly contains a number of moderately large spots, including at least one strong delta configuration, although appears to evolve slowly in terms of appearance. Despite this, it retains a complex magnetic configuration along with notable magnetic looping in the canopy above the sunspot. AR3691 (Dkc/Beta-Gamma-Delta) in the north centre disc is a moderately large sized bipolar group. The pre-existing delta spot occupying the intermediate portion of the group remains, but there are recent signs of some separation in the penumbra between the spots of opposing polarity and reduction in overall penumbral extent of the region. The other sunspot groups on the disc are small, simple and appear stable at this time.

Moderate Solar Activity is expected with a chance of isolated X-class flares throughout the period, these most likely from AR3697 and AR3691.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	Yes	75	75	75	75
Very Active	R3 to R5 X Class	No	20	20	20	20

Figure 3: Latest GOES16/18 X-Ray flux

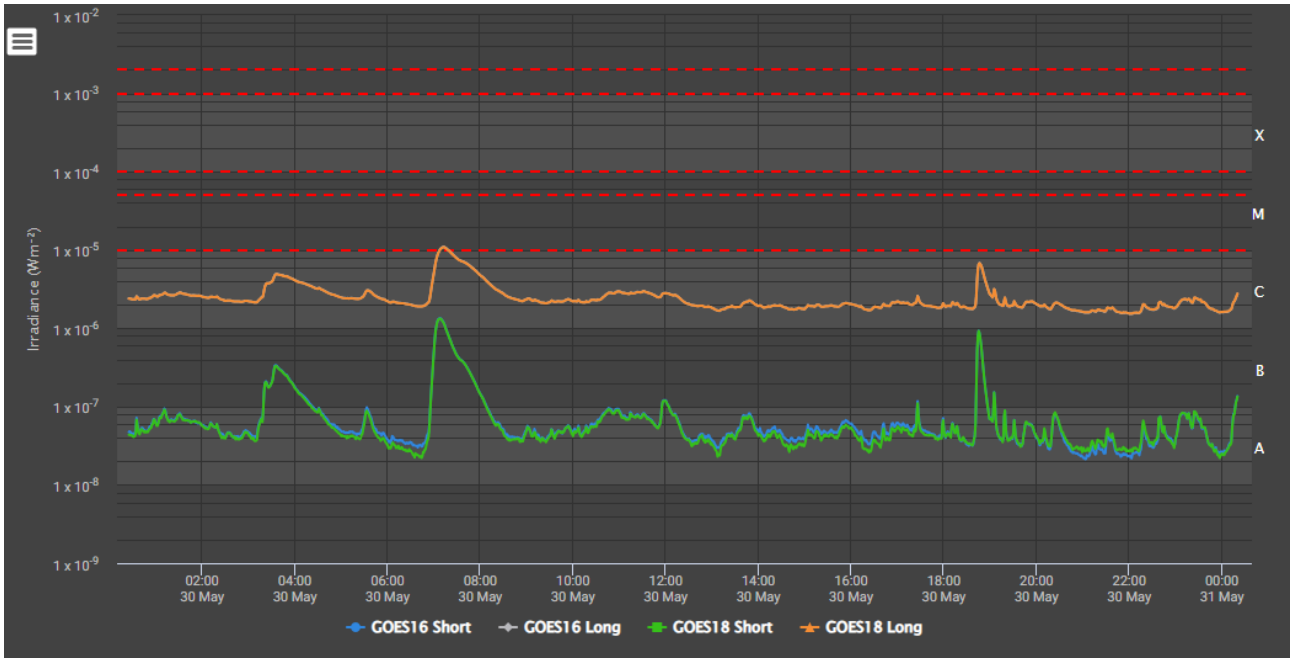

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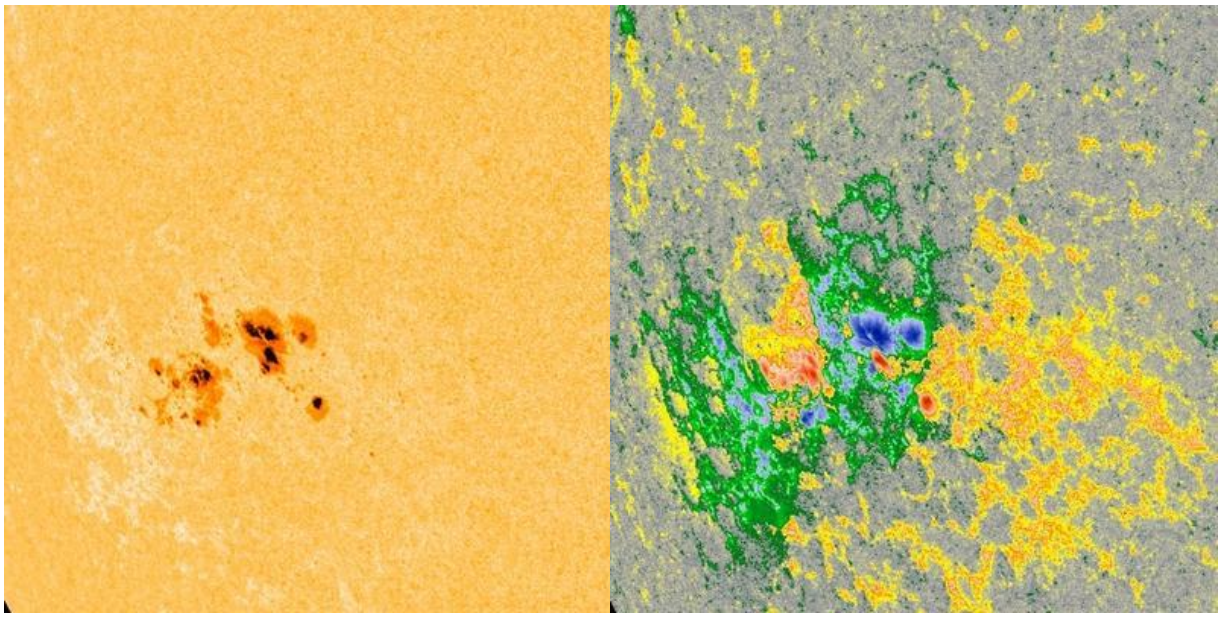
Figure 4: HMI-Intensitygram (left) and HMI-Colorized Magentogram (right) of AR3697



Solar Radiation Storms - (High Energy Protons):

GOES-18 proton flux is expected to persist at background levels, with a slight chance of rising to the S1/Minor Storm threshold given any further notable flares. These are most likely from either AR3697 in the southeast, or AR3691 in the north-centre disc. Both regions are considered to be in unfavourable locations for significant proton enhancements at GOES-18 initially, however the risk will marginally increase in the coming days as these regions continue to transit westwards into more geoeffective longitudes on the visible disc.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	15	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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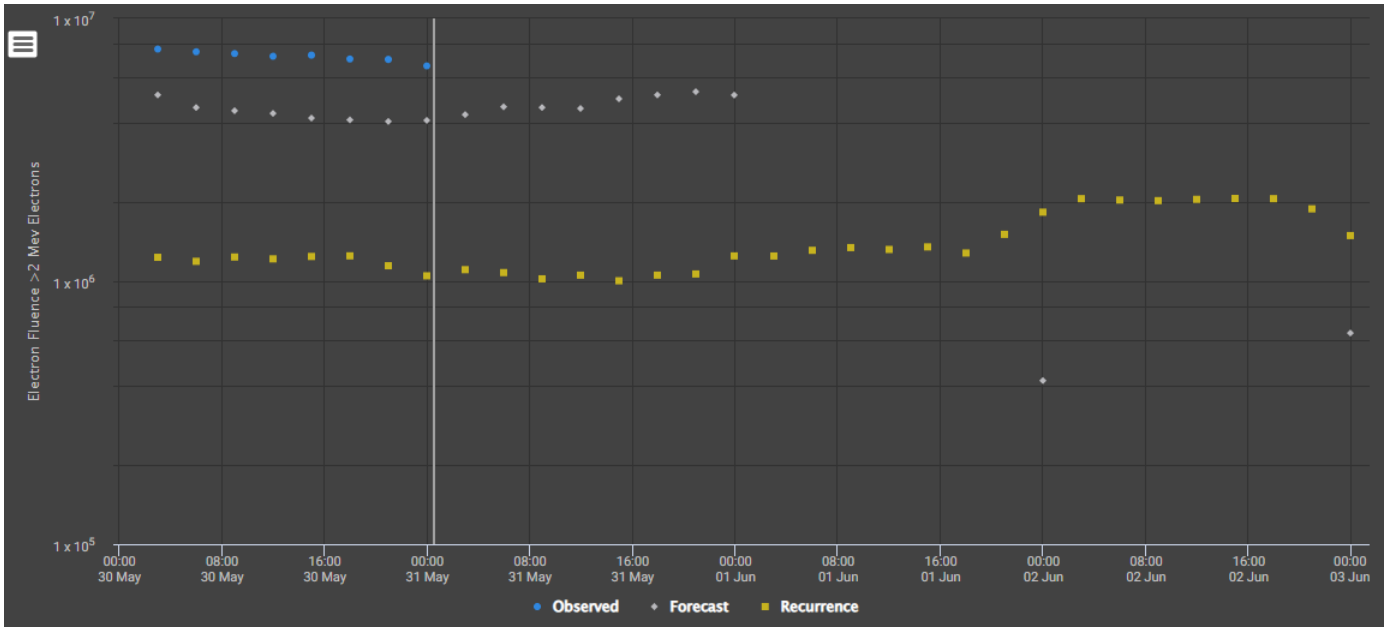
High Energy Electrons Event (≥ 2MeV):

GOES-16 electron flux is expected to remain at background to moderate levels on all days, with no significant sources of enhancement anticipated given only modest CME and coronal hole influences in the forecast. The associated 24 hour electron fluence is expected to remain below the Active level, as supported by MOSWOC REFM, which is giving reasonable guidance for the expected trend through the period.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	1
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: MOSWOC REFM forecast and recurrence



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